Effect of Oxidation on Electron Affinity and Surface Potential of the Diamond (001) Surface

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The understanding of the structural and electronic properties of diamond surfaces is important for further technological advances in both the growth of atomically controlled diamond films by the chemical vapor deposition method and the fabrication of diamond-based electronic devices. The diamond surfaces sometimes show unusual surface properties such as the surface conduction and very small and/or negative electron affinity[1,2,3]. The unique characters are strongly related with the chemisorbed species on the diamond surfaces. Hydrogen chemisorption on diamond are well-known to be important for stabilizing the diamond surface structures with sp3 hybridization[4,5]. Many reports have suggested the hydrogen chemisorption are necessary to give NEA condition on the diamond surfaces[6]. Oxidation of the diamond surface is another very important topic, because the diamond surface can be easily oxidized at elevated temperature (>300°C) in air or by treatment in acid solution[7]. The oxidized diamond surfaces usually show completely different phenonena from the hydrogenated diamond surfaces, and sometimes give the other unique properties [8]. In this paper, we investigates the relation between the aurface properties and the surface chemisorption on the single crystal diamond surfaces in the course of diamond oxidation processes.

Ultraviolet photoemission spectrum from the hydrogenated diamond (001) surface (as grown diamond) indicated the characteristic highly peaked emission feature (suggesting NEA peak) with a sharp cut-off at 16.2 eV BE (kinetic energy ~ 0) below the Fermi level [Figure 1]. After the oxidation at 550°C, the sharp peak at 16.2 eV disappeared and give a different feature suggesting that the electron affinity condition change to positive from negative.

Figure 2 shows the intensity of O on the diamond (001) surface evaluated by monochlomated X-ray photo emission spectroscopy after the oxidation at various temperature.

The work functions of the diamond surfaces after the oxidation were measured by scanning Kelvin force microscope (KFM) and scanning Maxwell-stress microscope (SMM) in Figure 3.

The effect of the oxidation for the chemisorption, surface potential and electron affinity of the diamond surfaces will be discussed in detail.

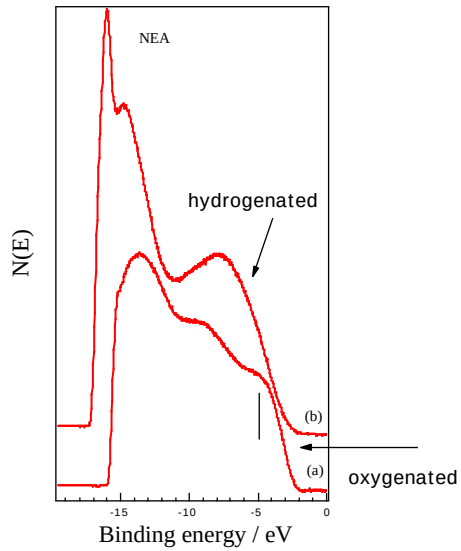

Figure 1 UPS from (a) the oxidized diamond (001)-1x1 and (b) thehydrogenated diamond (001)-2x1

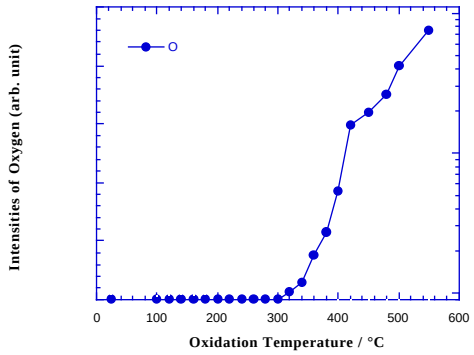

Figure 2 Effect of the oxidation temperature for the surface-oxygen intensity by XPS

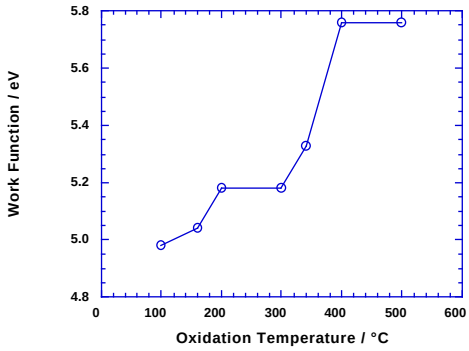

Figure 3 Change of the work function against the oxidation temperature by the scanning Maxwell-stress microscopic measurements

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